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CONTROL OF ARIZONA ROSE DISEASES

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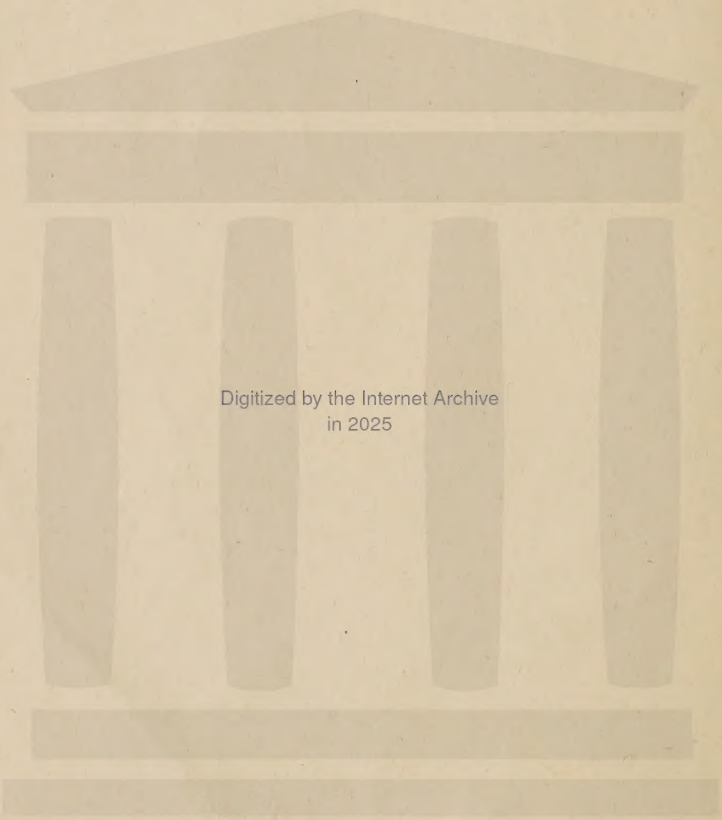

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KEY FOR IDENTIFICATION OF MALADIES OF ARIZONA ROSES

I. Plant dies suddenly (usually in hot weather), often within a week after first symptoms are noticed. **Root rot**

- A. Tiny tan fungus strands on roots, or spore mats on ground (cottony white at first, becoming tan and powdery). **Texas root rot** (2)*
- B. No signs of fungus. **Unidentified root rot** (6) **or too deep planting** (30)
- C. New feeding roots absent or scant. **Weak plant** (31), **too late planting** (27) **or poor condition** (28)

II. Plant stunted or yellowing, sometimes dies slowly:

- A. Small knots or galls ⅛ to ½ inch on fibrous roots, small feeding roots usually scant. **Root-knot nematode** (1) (*E*)†
- B. Large galls (½ inch to 6 inches), usually spherical, at crown of plant or on larger roots (occasionally on canes above ground). **Crown gall** (3) (*H*)
- C. No galls on roots but root and top growth stunted. **Alkali, drought, low fertility,** or **weak plant** (26, 27, 28, 29, 30, 31, 32, 33, 34, 35)

III. Definite lesions or dead areas on canes:

- A. Canes die from tips. **Dieback** (7) (*I, K*)
- B. Lesions beginning at pruning cuts or at crown. **Canker diseases** (11)
- C. New succulent growth distorted and covered with a whitish powder. **Powdery mildew** (4) (*A, B*)
- D. Gray mold on blackened areas on canes of roses held in moist packing. **Mold of canes** (13)

IV. Lesions, discolorations, or shedding of foliage:

- A. Round, dark brown to black spots ⅛ to ⅜ inch diameter on leaves. **Black spot** (8) (*Q*)
- B. Small irregular brown or black spots on older leaves in late summer. **Weather** (14)
- C. Irregular darkened splotches on exposed surface of leaf in late summer. **Weather** (14) (*S*)
- D. Powdery, whitish areas on leaves in spring, often causing curling and distortion. **Powdery mildew** (4) (*A, B*)

*Discussion of each disease appears in order of these reference numbers.
†Capital letters refer to illustrations.

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E. Small, orange-yellow, powdery, pin-point lesions, usually more abundant on lower surface of leaf **Rust** (9) (*C*)

F. Shedding of foliage. Usually due to severe form of **black spot** or **rust, drought,** or **other malady** (8, 9, 29)

G. Foliage pale green or yellowish.
   a) Leaf blade light green, veins green. **Mild chlorosis** (5) (*Uc*)
   b) Leaf blade and veins pale green to yellow. **Moderate chlorosis** (5) (*Ub*)
   c) Leaf margins brown and dry, center pale yellow. **Severe chlorosis** (5) (*Ua*)
   d) Leaf blade streaked or mottled with yellow, whitish, or pale green areas. **Virus diseases** (17) (*D*)

H. Tips or margins of young leaves dry and brown. **Hot, dry wind, drought, alkali, reflected heat** (16, 29, 35)

I. Tiny grayish green flecks on leaf. **Feeding of leafhoppers** (18) (*T*)

J. Bronzing and mottling of leaves. **Feeding of red spiders** (19)

K. Whitish spots on leaves or canes. **Scale insects** (20)

L. Leaves becoming brittle and shoots and buds cease growing **2-4-D sprays** (37)

V. Lesions or discolorations of flowers:

A. Drying of margins of petals:
   a) In hot weather. **Heat and wind** (21) (*O*)
   b) In cooler weather. **Variety not adapted** (31)

B. "Blueing"—change of color in some pink and red roses to an unpleasant purplish cast on exposure to light. **Variety not adapted** (22)

C. "Balling"—failure of petals to open properly:
   a) Without browning of petals **Variety not adapted** (23)
   b) With browning of petals at base. **Thrips** (23) (*P*)

D. Flowers with stunted, thickened petals showing tiny blisters. **Severe chilling in early spring or late fall** (24) (*M*)

E. Young tips killed and blackened in early spring or late fall. **Frost** (25)

F. A brown, moist rot of petals in wet spring weather. **Soft rot** (26) (*N*)

VI. Leaf buds near ends of cane fail to open or open late. **Delayed foliation** (36) (*J*)

CONTROL OF ARIZONA ROSE DISEASES

By R. B. Streets*

This bulletin replaces the author's bulletin 190 *Diseases of the Rose in Arizona* which has for some time been out of print. Many sections have been extensively rewritten and revised in the light of additional experience and published information, and a considerable amount of new information has been added especially on varieties adapted to this climate.

INTRODUCTION

The rose is deservedly popular in Arizona and elsewhere, both as an ornamental and for cut flowers. The climate of Arizona, especially the southern part, while in many respects favorable to the successful culture of roses, is in other respects unfavorable. The diseases and other factors causing poor growth in our state are correlated very closely with the type of climate we enjoy. Many of the most serious rose diseases, such as black spot, anthracnose, and cankers, have never been found in Arizona, and others serious elsewhere are not important here. There are, however, enough diseases which are obvious or important to call forth frequent requests for assistance. This publication should enable the rose grower to recognize the more prevalent diseases and apply control measures effectively. In case of doubt the grower may secure assistance by mailing to the Department of Plant Pathology, University of Arizona, Tucson, Arizona, freshly gathered samples showing if possible several stages of the malady, together with notes on conditions under which the plants are growing. The specimens should be loosely wrapped in waxed paper or slightly dampened newspaper and shipped at once after cutting.

Most of the inquiries about rose diseases come from the southern part of the state where the winters are mild and the summers hot, and the discussion centers around rose problems under those conditions. The information given, however, applies to the rest of the state, except that winter hardiness is a limiting factor at higher altitudes.

DISEASES OF MAJOR IMPORTANCE IN ARIZONA

1. ROOT-KNOT NEMATODE

A frequent and often unrecognized cause of poor growth in roses in the southern states is the root-knot nematode.

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Symptoms

The above-ground symptoms—stunting, yellowing of foliage, and premature death—might be due to other causes, so it is necessary to examine the fibrous roots for the characteristic swellings or knots about ⅛ to ¼ inch in diameter and up to ½ inch or more in length (Pl. II *L*). In some infestations the roots become matted; in others, many roots decay and the fibrous roots are scarce.

Enlarged lenticels (Pl. VI *V*) occurring on Odorata root have been confused with nematode galls.

Cause

The female nematode is a slender, microscopic round worm which forces its way into the tender root tips where it feeds, matures, and lays from 300 to 800 eggs. The eggs hatch and the young nematodes may live in the same root or emerge in search of other roots. Nematodes multiply very rapidly since there are as many as ten or fifteen generations a year in warm climates. Under optimum conditions a generation from egg to egg may require only 22 to 27 days. The optimum soil temperatures for the development of nematodes is about 80 degrees F. and the minimum is about 58 degrees F.; therefore the nematodes are much more active and injurious during the summer months. They are very difficult to eradicate, as they can survive in soil for months and the egg stage is resistant to drying and chemicals.

Control

There is no practical method of eliminating nematodes from infested roses. The hot water treatment recently advocated is still in the experimental stage and the temperature necessary to kill the nematodes in the root tissues also killed or greatly damaged the roots in many cases. Likewise, the chemicals which are effective in killing nematodes in the soil or in plant roots will also kill the roots of roses or other plants.

The practical measures for the control of the root-knot nematode in roses and similar plants may be classified in three groups: (1) Means of avoiding introduction of nematodes in a noninfested garden, or increasing infestation where nematodes are present; (2) Means of minimizing the injury caused by nematodes; and (3) Means of eradicating nematodes from soil in advance of planting or replanting.

To avoid introduction of nematodes, examine the roots of bare-rooted roses before purchasing or planting, and reject those showing root knot. In case of roses growing in cans, infestation can usually be detected by examination of roots on the surface of the ball of soil after the container is removed. Infested plants should be destroyed because it is impossible to detect and prune out all diseased roots.

Roses which are in poor condition as the result of nematode infestation should be promptly removed and destroyed and the soil treated or replaced before new roses are planted. The useful life of roses which show only slight to moderate injury can often

be lengthened by extra care and extra fertilizer, since infested plants suffer more in poor soils than in fertile ones.

In areas where nematode-infested soils are prevalent, the use of certain rootstocks relatively resistant to nematodes might avoid serious injury from nematode attack, providing the rootstock was adapted to the soil and climate of the district.

One rose understock has shown outstanding resistance, if not complete immunity to root knot. It is a thornless type of rootstock developed by Prof. T. J. Maney of Iowa from a cross of two species, *Rosa multiflora* and *Rosa blanda*, and now called the Multiflora-Blanda understock (2). No sign of infection was found during a three-year trial in Texas (5). This hybrid has some faults but is vigorous and tends to produce more flowers than other understocks. If further tests are satisfactory roses really resistant to root-knot nematode may be available in a few years.

Rosa setigera, a hardy species known as the Prairie Rose, has shown remarkable vigor, notwithstanding infection with nematode. The "Texas wax" understock is apparently no longer used as a nematode resistant rootstock.

In small areas, nematodes have been successfully killed in the soil by injection of chemicals such as formaldehyde (5% solution); carbon bisulphide (2 oz. per sq. ft.); chloropicrin (2 to 5 cc. per cu. ft. of soil, or sq. ft. of area treated); or "DD" compound. Chloropicrin (sold under the trade name Larvacide) has also considerable fungicidal value. To be effective these compounds must be applied to a warm soil and a gas proof cover or water seal maintained over the area treated. Arizona Bulletin 212, just published, gives a full account of the root-knot disease and methods of treatment.

2. TEXAS ROOT ROT

Roses are frequently attacked by Texas root rot, which, next to root knot, is the most serious and widespread plant disease in southern Arizona. See *Extension Circular 103* for a full account of this disease.

Symptoms

Rosebushes which are apparently healthy and thriving and then die suddenly during the months of June to September, inclusive, may be suspected of having Texas root rot. While the attack comes apparently without warning, a close observer would have noted a yellowing of the foliage and a tendency of the leaves to wilt in midafternoon for some days before the final attack. If the dead plants are dug up and the roots carefully examined, the presence of delicate strands of buff-colored fungus filaments on the surface of the roots (Pl. II) will establish the disease as Texas root rot. In case of doubt, it is advisable to refer the specimens to the Department of Plant Pathology for examination. During the summer months the fungus may appear on the surface of the ground as white mats of cottony filaments which within two or

three days turn to buff-colored powdery spore masses (Pl. VI *Bottom*). These are found especially after rains or where the soil is moist after irrigations.

Symptoms

Texas root rot is caused by a fungus, *Phymatotrichum omnivorum*, which is native to the soils of the semiarid Southwest and becomes very destructive to plants under irrigation where conditions for its growth are very favorable.

Control

Root rot is a most difficult disease to control, as it persists in the soil for years and attacks most of the commonly cultivated trees, shrubs, and other ornamentals. In fact, the dangers of spread to any other susceptible plants in a city lot of ordinary size is so great that prompt and vigorous action should be taken to eradicate root rot before the whole planting becomes infected.

Since the disease does not become evident until it has destroyed so much of the root system that the plant dies from lack of water, very prompt action is necessary to save infected plants.

A soil treatment originated by the writer for treating root-rot-infected pecan trees has also proved successful in treating shade trees and other ornamentals. The soil of the infected area is first loosened to aid penetration and a dirt bank about 6 inches high built around it. The ammonium sulphate* is scattered evenly over the soil at the rate of 1 pound to 10 square feet. Then an equal amount of agricultural sulphur* is added to the same area and stirred into the loose surface soil until the yellow color disappears. The basin is filled with water to a depth of 3 inches and the ammonium sulphate is carried down into the root zone. This treatment can be used without injury to living plants, either healthy or diseased, *if directions are followed closely*. The dosage is very strong and plants may be defoliated or killed if too little water is used. From one-half to three-fourths of the top growth should be removed from infected plants. Generous use of well-rotted manure or other organic matter is advised for roses in areas where root rot is prevalent.

3. CROWN GALL AND HAIRY ROOT

Crown gall is one of the common and serious diseases of the rose, gradually devitalizing the bushes and shortening their period of productivity and life.

Symptoms

Crown galls appear as roughly spherical, woody growths, usually on the rootstock below ground (Pl. II *H*) but occasionally on the canes above ground. They may occur at the point of grafting,

*Both materials are usually available from nurserymen and fertilizer dealers, but the supply of nitrogenous fertilizers has often been insufficient to meet the demand and at times ammonium sulphate may not always be readily available.

on the side where buds have been removed, or at the base of the rootstock. Galls on the roots themselves are often the result of infection through cuts and other wounds made in digging and transplanting. Galls vary in size with age and the size and vigor of the roots attacked. Crown galls from the size of a cherry to that of a baseball are commonly seen, although both larger and smaller specimens are not rare.

In hairy root, which is much less common than crown gall, no definite galls are produced, but an excessive number of weak fibrous roots appears (Pl. II *G*).

Cause

Crown gall is caused by a bacterium, *Agrobacterium tumefaciens;* hairy root by *Agrobacterium rhizogenes.* Both organisms overwinter in the diseased tissues of infected plants, but they may survive in the soil for a year or more. New infections arise at points where cuts and injuries have occurred.

Control

(a) Diseased plants should be destroyed, as the removal of galls usually fails to check the disease. (b) Before replanting where roses have been lost from crown gall, remove the soil to a depth of at least 2 feet and replace with uninfected soil. (c) Infection takes place only through wounds, so care should be used in planting. Prune off damaged roots. (d) All new plants should have the roots inspected before purchase or planting; those having suspicious lumps or swellings, or evidence that such gall-like swellings have been removed, should be rejected. (e) Recent experiments in this department have demonstrated that crown gall tissues and the bacterium can be killed by the injection of penicillin and that healthy tissues are unaffected by the treatment. This is the first curative treatment which has been developed for crown gall. Further research now in progress will, no doubt, throw further light on methods of treatment and control of crown gall.

Inspection

The State Department of Horticulture and Agriculture through its inspection service is performing a valuable service by inspecting all lots of roses and other nursery stock shipped into the state, and the stock of nurseries operating within the state, and condemning all lots harboring plant diseases or insect pests. The most common diseases intercepted are crown gall and root knot. Recently a lot of roses was intercepted in which an attempt had been made to cut off the crown galls.

4. POWDERY MILDEW

Another widespread and often important disease of roses is powdery mildew. It can usually be found in rose gardens of any size in Arizona.

Symptoms

The powdery whitish or grayish growth on the young leaves, flower buds, and tender canes readily identifies the disease (Pl. I *A, B*). These powdery, whitish spots which are made up of chains of small colorless spores (the "seeds" of the fungus) appear on the foliage as soon as the leaves begin to develop in spring. Mildew spreads rapidly in warm, damp weather, but it usually is checked by hot, dry weather in June. In very susceptible roses the powdery infection may spread over the leaves, young shoots, thorns, pedicels, and unopened buds, resulting in a drying and shedding of the foliage and unopened buds or the failure of buds to open properly. Plants are rarely killed by mildew, but their value as ornamentals is destroyed.

Cause

Powdery mildew is caused by fungus, *Sphaerotheca pannosa* var. *rosae*, which hibernated as the common spore stage or as perennial mycelium, especially in association with the buds.

Varietal susceptibility

Nearly all types of roses are more or less susceptible, but in our climate many escape serious injury. The ramblers, Dorothy Perkins and Crimson Rambler, both climbing roses, are so badly injured by mildew and so bleached by our intense sunlight that they had better be discarded and replaced by some of the excellent climbers which are resistant to mildew. Also the control of mildew in the rose garden is much easier in the absence of very susceptible varieties.

Among the climbers relatively free from mildew are Climbing Cecile Brunner, Cl. Red Radiance, Cl. Golden Emblem, Cl. American Beauty, and Cl. Hoosier Beauty.

Control

(A) Dusting sulphur (300 to 325 mesh), applied when the first leaves unfold and repeated at intervals of ten to fourteen days, gives good control of mildew. Small hand dusters costing a dollar or less will apply the dust to the home garden in a few minutes. Special attention should be given to securing an even distribution of dust, and the application should not be heavy enough to show plainly. The fungicide kills the superficial fungus which has developed and protects against further infection as well.

(B) Liquid sprays are preferred by some and will also control mildew. The following are the most commonly used sprays:

a) Concentrated lime-sulphur, one part in fifty parts of water.
b) Potassium sulphide (liver of sulphur), 1 ounce to 3 gallons of water, gives a spray which leaves no conspicuous residue.
c) Wettable sulphur sprays consist of finely ground (300 mesh) sulphur and a wetting agent such as glue, calcium caseinate, etc.

Caution

Do not use sulphur sprays where they will spatter on trellises or woodwork painted with *white lead* paint, as the spray will react with the lead oxide and form black lead sulphide stains. Paints made with zinc oxide will not discolor, as zinc sulphide is white. A drop of spray mixture on the painted surface will indicate whether or not your paint will discolor.

5. CHLOROSIS

Chlorosis, or lack of normal green color, is general and severe in roses as well as in many other woody plants in Arizona. While chlorotic foliage may be due to any of a number of causes, it is generally associated in some way with the physiology of the plant. A deficiency of nitrogen, magnesium, or iron, or subjecting the plant to unfavorable growing conditions such as low temperatures, excessive moisture, or disturbed mineral ratios (manganese-iron or phosphorus-iron) may induce chlorosis, but the most common form encountered in arid climates is called lime-induced chlorosis.

Symptoms

Three definite degrees of chlorosis are easily recognized, and if no steps are taken to correct the cause, plants may pass rapidly from one stage to the next.

a) *Mild chlorosis.*—The young leaves show normal green veins with paler green areas between (Pl. VI *Uc*).

b) *Moderate chlorosis.*—The young leaves lack normal green color; both the blade and veins are pale green to yellow (Pl. VI *Ub*).

c) *Severe chlorosis.*—Leaf blades are pale yellow with margins and tips brown and dry (Pl. VI *Ua*). Plants in this stage often die slowly. Chlorosis is most prononced in the youngest leaves on the growing tips. The older leaves of plants recently affected may be a normal green.

Cause

The exact cause and mechanism of lime-induced chlorosis has been the subject of much speculation. Wann (13) offers the following summary: It was at one time supposed that lime-induced chlorosis could be explained by assuming that the lime in the soil produces an alkaline reaction which precipitates the iron, thus rendering it unavailable for plants. Since it has been shown repeatedly that the total iron content of chlorotic and green leaves is very similar, this explanation is no longer tenable. It seems more likely that after the iron is absorbed and transported to the leaf it may be rendered "inactive" by some upset in the physiological balance in the living cells, the nature of which is at present unknown. Chlorotic leaves frequently have a higher potassium content than normal leaves, but whether this is the cause or effect of chlorosis is uncertain.

Preventing chlorosis

Chlorosis is more prevalent and severe where soils are deficient in organic matter. Annual applications of manure supplemented by commercial fertilizer (nitrogen and phosphate) will to a large extent prevent chlorosis (11).

In preparing new rose beds, removing the soil to a depth of 24 to 30 inches and mixing with the soil generous amounts of manure to which has been added sulphur, ¼ pound and ammonium sulphate 1 ounce per cubic foot of soil gives good insurance against chlorosis.

Rose varieties which have Pernet "blood" in their ancestry are particularly susceptible to chlorosis. These varieties usually show some yellow or orange or yellow shading in the petals, and include many of the new varieties. Talisman and Joanna Hill are examples. On the other hand, any of the red or pink flowered varieties that are crimson or crimson pink, that is, have a bluish tinge, will normally do well in fairly alkaline soil (11). The following are a few varieties: Radiance in all its forms, Briarcliff, Etiole de Hollande, Imperial Potentate, K. A. Victoria, Premier Supreme, and Editor McFarland.

Control

Chlorosis may be treated in three different ways:

a) Supply soluble iron to the plant roots by making holes in moist soil in the root area from 3 to 9 inches deep and putting in each hole 1 heaping tablespoonful (about 1 ounce) of ferrous (iron) sulphate. Apply ½ to 1 pound per bush. Each irrigation will cause sufficient soluble iron to diffuse to adjacent portions of the root system to supply the plant. The same amount of iron salt broadcast over the soil is relatively ineffective as most of it is rapidly fixed in unavailable form. One treatment is usually effective for two to four years. Marked recovery usually occurs within a month after treatment.

b) Make soil conditions more favorable by application of agricultural sulphur and manure at the rate of 2 pounds of sulphur to a cubic foot of manure. Scatter the sulphur on the manure and mix it well with the surface soil. Improvement should be noted within one to two months. Application of iron sulphate in holes is also used to supplement this treatment.

c) Regulation of water is also necessary, as chlorosis is aggravated by excess water.

ROSE DISEASES NEEDING FURTHER INVESTIGATION

There are two diseases, or rather types of injury to roses, which are more or less prevalent and sometimes destructive in Arizona rose gardens. Concerning these we greatly need more definite information.

6. ROOT ROT

For lack of a better and more descriptive name, the most serious of these diseases is for the present called simply "root rot," as

this describes the principal symptom, the sudden death of the root system followed by a drying of the top. Isolations made from the recently killed roots of such plants yield the usual variety of organisms recovered under such conditions, including several species of the fungus Fusarium. The disease has not yet been produced by inoculation with pure cultures of any of these organisms (so the cause is still unproved). The disease appears to be most severe from midsummer to late summer—a period of stress for the plant. Investigations are being continued to prove whether this is a single disease or a group of similar root rots with different causes, and to determine methods of control.

7. DIEBACK

The term dieback is used to designate the dying of the tips of twigs or branches of trees or shrubs, beginning at the tips and progressing toward the base. Dieback of the rose (Pl. III *I, K*) is not a specific disease due to one definite cause, but a symptom of impaired vigor due to one or more of the following conditions: deficiencies of plant food or water; excesses of plant food (for example, nitrogen) or soluble salts (alkali) or water; defoliation by black spot or rust; injury from canker diseases or root rots; infection by weakly parasitic fungi (such as *Diplodia* spp. or species of about eight other genera); chlorosis; winter injury; or in fact, any other agency which would lower the vitality of the plants.

Control

The first step in control would be to determine which of the above agencies is causing the dieback occurring under Arizona conditions and to apply appropriate control measures. Observations are in progress to determine what factors are primary in causing dieback in Arizona roses.

DISEASES RARE OR NOT KNOWN TO OCCUR IN ARIZONA

The following rose diseases, although not at this time of common occurrence or importance in Arizona, are briefly discussed on account of their prominence in rose literature and to assist Arizona rose growers to recognize and if possible eradicate them if they should appear in the state.

8. BLACK SPOT

While black spot is the disease listed first in the order of usual prevalence and importance wherever the rose is grown, no authentic record of its occurrence in Arizona is known to the writer. Inquiries among experienced rose growers have failed to produce evidence of its occurrence in the state.

Symptoms

Black spot is principally a disease of the leaves, although it may also occur on the leaf petioles, flower peduncles, or on the canes. The spots on the leaves are black, nearly circular (Pl. V. *Q*), and can be distinguished from other leaf spots by a darker and more

uniform color and a fringed margin which is evident only upon close observation. The spots are from 1/16 to ½ inch in diameter and frequently run together, producing irregularly shaped lesions of large size. Often the zone around the lesions or the entire leaf turns yellow and may be shed prematurely. When black spot is severe the plants may be partially or almost completely defoliated during the growing season. Cane lesions occur as dark, raised, irregular blotches on tender, immature wood.

Following early season defoliation, leaf buds which should remain dormant until the following year may open late in the season. This results in improperly matured wood and weakened plants subject to other diseases and injuries.

Cause and life history

Black spot is caused by a fungus (*Diplocarpon rosae*) which overwinters either in leaves remaining on the bushes, in cane lesions, or in infected rose leaves on the ground. The distribution of black-spot spores is dependent on high humidity and moisture on the leaves from rain or sprinkling with a hose. Penetration of the leaf is rapid, requiring only eight to twelve hours under favorable conditions, and the lesions may become visible in about a week. The new lesions soon produce spores, and the cycle is repeated as long as the weather is favorable. The absence of black spot from Arizona rose gardens is apparently due to prevailing low humidities and long intervals (often three or four months or more) between rains.

Control

(a) During the dormant season, collect and burn all infected leaves, stripping the remaining leaves from the plants and raking the ground. The black-spot fungus overwinters on the canes as well as in the leaves, so the cleanup must be followed by spraying or dusting.

(b) Dust plants at weekly intervals starting at the first appearance of black spot. Discontinue dusting or reduce to once every two or three weeks during hot, dry weather, as too heavy or too frequent use of sulphur will cause burning of the foliage. The most effective dusts contain 90 per cent of an unconditioned 325-mesh (dusting) sulphur and 10 per cent of an insoluble copper compound (8). If cuprous oxide (Cuprocide) is used, the sulphur should be conditioned.

(c) Select varieties such as Radiance, Etoile de Hollande, Edith Nellie Perkins, and Lady Hillingdon which are least affected by black spot. Of the newer varieties Pink Princess is outstanding in black spot resistance (12).

9. RUST

Although a serious disease in England and widespread and sometimes destructive on our Pacific Coast from San Diego to Vancouver, British Columbia, rust is rare indeed on garden roses in this state, having been found only on plants recently imported

into Arizona. A recent study (3) revealed that the summer rust spores could infect the leaf only when the surface was wet with liquid water for at least four hours and a favorable temperature, 64-70 degrees F. prevailed. Practically no infection occurred above 80 degrees. Rainfall is scant here in the spring and fall months when the temperatures are favorable for rust infection.

Symptoms

A yellowing of the leaves followed by premature defoliation is the most conspicuous symptom of rose rust. The disease is also easily recognized by small orange spore masses which usually occur on the under surface of the leaves in early summer. These spore masses form on yellow-orange spots visible from either side of the leaf (Pl. I *C*). Similar lesions may occur on the canes. In late summer and autumn very tiny black spore masses are produced on the infected leaves (Pl. I *C*).

Cause

The rust fungi are often highly specialized in regard to the species and varieties of host plant they can attack, and the nine species of Phragmidium which attack roses appear to follow this pattern. The species occurring on cultivated roses having large leaflets, which includes our hybrid teas, is *Phragmidium mucronatum* (or *P. disciflorum* in earlier usage). Rose rusts are common on the native species of roses throughout the United States (including the mountains of Arizona), but the wild-rose rusts apparently do not spread to the cultivated roses.

Control

If rust appears: (a) When the plants are dormant or semidormant, strip them of infected leaves and rake and burn fallen leaves. (b) As soon as growth starts, apply dusting sulphur or a sulphur spray at weekly intervals until hot, dry weather begins. Infection takes place through the under surface of the leaves, so use special care to cover them thoroughly.

10. ANTHRACNOSE

Anthracnose, caused by the fungus *Sphaceloma rosarum,* is of wide distribution but has not yet been found in Arizona. It is often confused with black spot or other leaf-spot diseases. Rose anthracnose affects all aerial parts of the plant, but it is most conspicuous as a leaf spot. The mature lesions have an ash-gray center with spore-bearing bodies and a dark brown definite margin often surrounded by areas of yellow, red or brown (Pl. V *R*). The control is the same as that for black spot.

11. CANKER DISEASES

There are at least four fungi which produce canker diseases of the rose. While each of these cankers is more or less common in certain parts of the United States and under certain conditions causes considerable damage, they are apparently of minor importance in Arizona. They are similar in appearance, method of infection, and control, so they can be considered together.

Symptoms

Cankers are lesions starting usually from the cut end left by pruning or cutting flowers, or developing at an injury near the base of the plant (Pl. III *L*). They gradually enlarge, often becoming several inches in length. Cankers at the base of the plant usually girdle the infected cane, which dies. Older cankers bear the tiny fruiting bodies of the fungi which cause them and furnish spores which spread the infection. The rose cankers in approximate order of their prevalence and importance are:

a) Brown canker (*Diaporthe umbrina*) forms dark brown cankers which may have a purplish margin. It may also attack leaves and blossoms.

b) Stem and graft canker (*Coniothyrium fuckelii*). The lesions appear as small pale yellow or reddish spots enlarging to form dry, wrinkled, or cracked cankers bearing numerous minute black spore bodies.

c) Brand canker (*Coniothyrium wernsdorffiae*) was prevalent and severe in a northern state where climbing roses were laid down and covered with soil to prevent winter injury. When the soil covering was omitted the disease disappeared.

d) Crown canker (*Cylindrocladium scoparium*) attacks the base of the canes and is principally a greenhouse disease.

Control of cankers

Since infection occurs principally through wounds made in pruning or cutting flowers (although any other injuries, such as the breaking of thorns from the cane, can result in infection), special care should be taken to make the cuts properly. In fact, the most effective prevention of canker diseases has been obtained by using sharp pruning shears which will not bruise the cane, making each cut ¼ inch above a bud, slanting the cut away from the bud. These short stubs rarely become infected. In removing side branches, cut as close as possible to avoid leaving a stub. Cuts over ¼ inch in diameter may be better protected by applying a fungicide or wound dressing, such as tree paint or orange shellac.

12. LEAF SPOTS

A number of leaf spots and other minor diseases are omitted, as they are not known to occur in the state and their inclusion might lead to confusion.

13. MOLD ON CANES

Roses shipped into the state from distant nurseries are usually carefully packed in moist peat moss or straw to prevent drying out of the roots and canes. If kept too long in such packing or exposed to warm temperatures some of the canes may blacken and become covered with a fungus growth, usually grey mold (*Botrytis* sp.). The canes affected are usually the smaller, weaker ones or those broken or otherwise injured and these should be removed before planting the bushes.

FOLIAGE DEFECTS

14. SHEDDING OF FOLIAGE

The two most frequent causes of midsummer shedding of foliage (black spot and rose rust) are no problem in Arizona, but shedding can be caused by drought or other unfavorable conditions. Many books and articles on rose culture recommend a summer period of rest and dormancy achieved by withholding water, but these instructions cannot safely be followed in southern Arizona. In spite of thorns the rose is not a cactus and will not thrive if obliged to go without water for long periods. A light irrigation every ten to fourteen days is a minimum for the summer rest period—or for the winter dormant period, for that matter.

15. DISCOLORED FOLIAGE

Beginning in late spring and increasing in severity through summer and fall, rose foliage in southern Arizona shows several types of injury from heat and dry air. The spots are often confused with black spot or other diseases, so it is desirable that their true nature be recognized.

The most common types of injury seen are (a) small irregular brown or black spots and (b) irregular darkened splotches on the exposed surface of the leaf (Pl. V *S*). These appear on the older leaves in late summer and are more prevalent on plants in poor soil, in very hot locations, and with irregular water supply.

16. DRYING OF TIPS AND MARGINS

The tips and margins of young leaves not yet fully matured may become dry and brown from exposure to dry, hot wind, drought, alkali, or reflected heat.

17. VIRUS DISEASES

There are at least four recognized virus diseases of the rose in the United States: mosaic, two yellow mosaics, and streak. Of these only one, a yellow mosaic, has been found in Arizona and this on a few plants imported from another state. The leaf blades in yellow mosaics are marked with broad bands and chlorotic blotches without much distortion.

Since the virus diseases of roses in America, as we know them, are not spread from plant to plant, it makes little difference whether diseased plants are removed or left in place. The viruses are apparently not spread by insects or by pruning or handling. Infected buds, scions or rootstock cuttings will, however, spread virus diseases, and should be avoided in propagating roses (7).

Virus infected roses may show little reduction in vigor or they may be slightly to severely dwarfed, and blossoms may be severely dwarfed, pale and unsymmetrical. Such plants should be destroyed.

The following three *maladies* are *often confused with plant diseases* and are listed here on that account.

18. Tiny, grayish green flecks on the leaflets are due to the feeding of leafhoppers (Pl. V *T*).

19. Bronzing and tiny mottled patterns on leaves are due to the feeding of red spiders.

20. Small oblong, whitish spots on leaves or canes are wingless sucking parasites called scale insects.

The Department of Entomology can furnish control measures.

BLOSSOM BLIGHTS

21. DRYING OF PETALS

In hot weather the drying of the margins of petals (Pl. IV *O*) is so common an occurrence in nearly all varities that it limits the value of the midsummer bloom. It is least prevalent under the best growing conditions—deep, rich soil and adequate, well-regulated irrigation. For cut flowers, drying can be avoided by cutting the roses as buds very early in the morning (at least by 8 o'clock) and allowing them to open indoors. Lack of soil moisture is a common cause of drying of the petals. Watch soil moisture carefully during the spring bloom!

Some roses with thin, delicate petals show more or less drying, even in the comparatively cool spring and fall blooming seasons. These varieties are not adapted to our climate and should be discarded.

22. "BLUEING"

The petals of some pink and red roses change color to an unpleasant purplish hue on exposure to our intense sunlight and heat. Varieties such as Climbing American Beauty showing a marked tendency to blueing are not adapted and should be discarded.

23. "BALLING"

Failure of the petals of the bud to open properly is called "balling," and such blossoms are worthless. If balling occurs without a browning of the petals at the base due to the feeding of thrips, the variety is not adapted and should be discarded. Columbia and La France are subject to balling, especially in spring. Some varieties ball in a moist, cool climate, others in a hot, dry climate.

If the base of the petals is browned or tiny brown spots appear on the petals (very conspicuous on white or light-colored varieties) the balling is caused by tiny, slender insects called thrips. The Department of Entomology will furnish directions for control of thrips.

24. DEFORMED BUDS

In early spring or late fall certain buds may show stunted and thickened petals bearing tiny blisters, and these buds often fail to open normally (Pl. IV *M*). This condition is due to severe chilling (just short of freezing). Certain varieties very sensitive to thrips injury may develop deformed buds or flowers when the attack is severe (Pl. IV *P*).

25. FROST

While rosebushes and climbers are usually only semidormant during the coldest weather in southern Arizona, they seldom show winter injury. An occasional spring frost catches the tender growth and the buds and tips of canes are killed and blackened, but growth is promptly resumed and no treatment is necessary. Tea roses are more tender than the common hybrid teas and should be planted in more protected locations.

26. SOFT ROT

A brown, moist rot of petals (Pl. IV *N*) is sometimes encountered during wet spring weather. This is due to a bacterial invasion of the tender petals which causes a soft rot, but it usually disappears as soon as our normal, dry, sunny weather returns. The fungus *Botrytis* which causes a similar moist rot in other states has not been observed here.

OTHER CAUSES OF FAILURE WITH ROSES

The following causes of failure with roses are listed more or less in the order of their importance and the frequency with which they are encountered.

27. LATE PLANTING

For most purposes January is the best month for planting *bare-rooted* roses in southern Arizona, although the favorable season extends from December 15 to February 15. Most of the roses sold in Arizona are grown in California and Texas and do not become dormant enough to permit digging until December, so they are usually not delivered to Arizona dealers until early January or later. For best results, buy and plant roses as soon as they are available.

Prevailing temperatures following late planting stimulate top growth at the expense of root growth. This often results fatally about midsummer. Bare-rooted roses should be planted before the buds break and top growth begins.

After February 15 it is advisable to plant roses which have been well started in cans. The better nurseries now plant all unsold roses in cans at an earlier date than formerly, and with better care they now produce roses satisfactorily for late spring planting. Care must be taken not to break the ball of soil and injure the roots while removing the can.

28. POOR CONDITION OF PLANTS

Frequently roses, carefully planted at the proper season in good soil and well cared for, will still fail to thrive and even die, to the bewilderment of the owner. It is difficult to diagnose this condition accurately by examining the plants two to six months later; but the writer has, over a period of years, planted many lots of roses. In most cases the roots were moist and the canes green and "plump" (not shriveled). The failure of these plants under careful irrigation appears to be due to a lack of vitality.

When dug out after failure to grow or after new shoots appear, then die, it is clear that the plant was not able to develop new feeding roots, and become established. The most common causes of this behavior are: (1) lack of proper ripening or maturity of the canes. Plants with soft, succulent canes (however green) do not thrive in this climate; (2) too long storage under improper conditions will devitalize good stock. Losses as high as 50 per cent are not uncommon in stock secured from some of the largest and best known rose nurseries. Retailers have experienced almost complete losses of lots of "cold storage" roses. The gardener can only be guided by experience in meeting this problem.

A more frequent cause of failure, however, which is not the fault of the rose grower, is poor condition due to improper handling by the retailer or purchaser after the stock has been received in good condition. The canes, and especially the roots, must not be permitted to dry out, and this means keeping the roots *constantly* covered with moist sphagnum moss, peat moss, straw, sawdust or other packing. A few minutes' exposure to our sun and dry air will kill the tiny feeding roots and delay or prevent the establishment of the plants.

Most nurseries are careful to keep bare-rooted plants with their roots well buried in peat moss or other material. Dealers who sell plants as a side line often do not have personnel trained in the care of plants, and the plants exposed in a warm, dry store may become too dry. Packaged roses, even those whose canes have been dipped in paraffin to retard drying, have often been observed in poor condition.

Most packaged roses would produce better plants if they were packed with a larger root system and the canes pruned back to three or four buds.

Roses showing drying or wrinkling of the canes are a poor risk, and will seldom produce satisfactory plants if they survive at all. The burying of roses showing wrinkling of the stems in moist soil (tops and all) for several days has often been recommended to replace water lost from the canes. The writer's experience with this method indicates that it is of value only in the early stages of drying and with plants otherwise of first class vigor.

29. POOR SOIL CONDITIONS

Most Arizona soils are too alkaline and too deficient in humus for the best results with roses. Both conditions can be improved by spading in well-rotted manure or other organic matter to which has been added 1 pound of agricultural sulphur per cubic foot of manure.

Our heavy (clay or adobe) soils may have poor drainage and poor aeration, while the lighter soils are often underlaid with caliche or hardpan, which may likewise cause poor drainage. Rose roots will die in soil that is constantly too wet.

Nitrogen is the fertilizer element most often deficient in Arizona soils, and additions of manure and commercial fertilizers like

ammonium sulphate, calcium nitrate, or sodium nitrate will stimulate growth in all except perhaps our richest agricultural soils. One pound to 25 square feet of bed applied in January or February followed by a generous irrigation should be sufficient for one year.

30. TOO DEEP PLANTING

Care should be taken in planting that the point of budding or grafting (marked by a definite swelling and angle in the stem) be set, preferably at the soil line, but in any event not over 1 or 2 inches below the soil surface. Deeper planting has proved unfavorable under our conditions, and many plants set with the bud union 3 to 6 inches below the surface have died, when all other growing conditions appeared to be favorable. This point should be emphasized as deep planting is a very common practice and an important cause of failure of roses to grow well.

31. VARIETY NOT ADAPTED

Many varieties which are gorgeous in the cool, moist climate of the Pacific Coast are not adapted to southern Arizona's hot, dry climate. Conversely, some of the varieties most successful here are of little value on the Coast.

The following varieties of roses have been selected on the basis of disease resistance, general vigor, and adaptability to the climate of southern Arizona on the basis of the writer's observations and experience as an amateur rose grower during the past twenty-three years. The list does not attempt to include all the "best" roses but suggests representative varieties of each color that have proved generally satisfactory.

If a rose does not produce satisfactory growth within two years under good cultural conditions, it is a poor variety, a poor bush of a good variety, or diseased. **Pull it out!**

The new circular *Roses for Yuma County* by Mrs. Allen (1), available at the office of the County Agricultural Agent in Yuma will be found very useful to those who reside in that area.

TABLE 1.—OLDER VARIETIES OF ROSES WELL TESTED FOR ADAPTATION TO CLIMATE OF SOUTHERN ARIZONA

BUSH ROSES	CLIMBING ROSES
Red	**Red**
*Hadley—early	*Cl. Hadley—early
*Hoosier Beauty	*Cl. Hoosier Beauty
Etiole de Hollande	Cl. Etoile de Hollande
†Red Radiance	†Cl. Red Radiance
Ragged Robin—for hedges	Paul's Scarlet—decorative
Pink	**Pink**
*Los Angeles	Cl. Los Angeles
†Rose Marie	†Cl. Rose Marie—everbloomer
Imperial Potentate	Belle of Portugal—very early,
†Pink Radiance	blush pink, vigorous

*Some fall bloom.
†Good fall bloom.

TABLE 1.—OLDER VARIETIES OF ROSES WELL TESTED FOR ADAPTATION TO CLIMATE OF SOUTHERN ARIZONA—*Continued*

*Briarcliff
*Dainty Bess—single

Pink-Yellow blends
Mme. Edw. Herriott—decorative
†Talisman
*Herbert Hoover

Yellow shades
*Mrs. E. P. Thom—yellow
Golden Emblem—deep yellow
†Joanna Hill—apricot
Angele Pernet—burnt orange
*Sunburst—apricot

White
*Frau Karl Druschki
Caledonia
Kaiserine Augusta Victoria
Mme. G. Staechlin—ruffled petals
American Pillar—single, vigorous
Cl. Dainty Bess—single

Pink-yellow blends
Cl. Mme. Edw. Herriott—decorative
*Cl. Talisman
Cl. Herbert Hoover

Yellow shades
Cl. Mrs. E. P. Thom—yellow
Cl. Golden Emblem—deep yellow
Cl. Sunburst—apricot
Yellow Banksia—apricot

White
Cl. Frau Karl Druschki
Silver Moon—semidouble
White Banksia

Polyantha
*Cl. Cecile Brunner

TABLE 2.—NEWER AND PATENTED ROSES ADAPTED TO CLIMATE OF SOUTHERN ARIZONA

BUSH ROSES	CLIMBING ROSES
Red	**Red**
†Crimson Glory	*Cl. Crimson Glory '46
Christopher Stone	†Cl. World's Fair
†Heart's Desire	†Blaze
*†Mirandy '45	
Flame and Carmine	**Flame and Carmine**
†Charlotte Armstrong	†Cl. Texas Centennial
†Mme. Henri Guillot	
†Texas Centennial	
Margaret McGredy	
Grand Duchess Charlotte	
Pink	**Pink**
Picture	†Cl. Picture
J. Otto Thilow	
†Santa Anita	
*†Show Girl '46	
The Doctor	
Multicolor	**Multicolor**
Betty Uprichard	Reveil Dijonnais
†Signora	
Mme. Joseph Perraud	
Condesa de Sastago	
Copper Shades	**Copper Shades**
Mrs. Sam McGredy	†Cl. Mrs. Sam McGredy
Hinrich Gaede	†Cl. Hinrich Gaede
Duquesa de Peneranda	Cl. Duquesa de Peneranda
Salmon-Pink	**Salmon-Pink**
†Comtesse Vandal	Cl. Comtesse Vandal
Treasure Island	

*Variety introduced less than five years ago, or looks promising on basis of limited tests.
†Patented variety, or patent applied for.

Yellow	**Yellow**
†Eclipse—v. long bud	*High Noon '46
McGredy's Yellow	
Golden Dawn	
*†Peace '45	
Soeur Therese	
*Polly—yellow, v. fragrant	
White	**White**
McGredy's Ivory	†Cl. Summer Show
Snowbird	Cl. McGredy's Ivory
Caledonia	*City of York '45
Semidouble	**Semidouble**
Lulu—deep orange-red, long bud	
Padre—coppery scarlet	
Irish Charm—blush pink	
Single	**Single**
Cecil—golden yellow	Kitty Kininmonth—deep pink
Innocence—white	Mermaid—yellow
Isobel—light rose pink	

TABLE 3.—FLORIBUNDA AND POLYANTHA ROSES ADAPTED TO THE CLIMATE OF SOUTHERN ARIZONA‡

Dark Red

†World's Fair—velvety deep red, 3" semidouble, bushy 30"§
Nigger Boy—dark crimson, 2" double; 24-30"
†Donald Prior—deep red, 8 petals; 30-36"
†Holstein—deep red, 6 petals; 24-30"

Red

Kirsten Poulsen—bright scarlet, 2½" single; 30-36"
†Anne Mette Poulsen—crimson red, 2½" double; 30-36"
*†Floradora '43—cinnebar red, 2" double; 24-30"
*Red Ripples '42—scarlet, 2" double; 30-36"

Deep Pink

†Crown of Jewels (Little Beauty)—glowing pink, 2" double; 24-30"
†Permanent Wave—deep pink, 5-8 wavy petals; 30-36"
Cheer—deep rose pink, 4" semidouble; 24"

Pink

†Betty Prior—shell pink, reverse deep pink, 3" single; 36-42"
Else Poulsen—rose pink, 2" semidouble; 30"
Ellen Poulsen—cherry pink, 2" double; 24-30"
Rosenelfe (Rose Elfe)—rose pink, 2-2½" double; 20-24"
Mrs. R. M. Finch—rose pink, 2½" double; bushy, 30-36"
*Pink Bountiful '44—rose pink, 3" double; 30-36"
*The Fairy '42—pink, 2" double; 20-24"
Cecile Brunner—light pink, 1" double; 24"

Salmon and Shaded Yellow

†Pinocchio—salmon, shaded pink, 2" double; 20-24"
†Rochester—soft yellow reverse shaded pink, 2½" double; 24-30"

*Variety introduced less than five years ago, or looks promising on basis of limited tests.
†Patented variety, or patent applied for.
‡The large-flowered (Floribunda) and small-flowered (Polyantha) roses bear flowers in clusters and bloom more constantly than any other roses. They more nearly approach an ever-blooming shrub than any other ornamental and should be much more widely used than they are now.
§Average height of three-year-old bush.

TABLE 3.—FLORIBUNDA AND POLYANTHA ROSES ADAPTED TO THE CLIMATE OF SOUTHERN ARIZONA—*Continued*

Yellow
*†Goldilocks '45—golden yellow, 3" double; spreading 30"
*†Marionette '42—cream yellow, 1½" double; 20-24"

White
†Summer Snow—white, 2½" double; spreading 20"
†Snowbank—creamy center, 2" semidouble; 18-24"
Dagmar Spaeth—white, 2" single, wavy petals; 20-24"
*Pedrables—cream to white, 4", 10-14 petals; 24"

32. ROOTSTOCK NOT ADAPTED

At least four different rootstocks are used commercially for roses, and no definite information is available concerning which is the most satisfactory for southern Arizona. Ragged Robin is the stock most generally used and is usually considered the best rootstock. Odorata shows promise, but not enough bushes have been grown on this stock to establish its value. Failures may be due to rootstocks not adapted to Arizona soils and climate (Pl. II *F*).

33. TOO HEAVY PRUNING

Cutting back the bushes to two or three canes 6 inches high, as frequently advocated, often results in short-lived bushes in this climate. Here better growth and more flowers are secured by moderate pruning, which develops a much larger bush that shades the ground and shows less injury from heat.

Heavy pruning developed in the colder northern states where winter temperatures often killed back the canes, and has also been used to secure long-stemmed "exhibition" roses. This end is accomplished at the expense of the number of blossoms produced during the season. There are three principal types of pruning for bush roses:

(1) *Heavy pruning* to three or four canes 6 to 8 inches high produces, as stated above (when disbudding is practiced), a few, very large, long-stemmed blossoms of show quality, but the bushes are often short-lived in hot climates.

(2) *Moderate pruning.* In the warmer parts of the Southwest, better growth of the bushes and more flowers are secured by moderate pruning to five to seven canes about 15 to 18 inches high, which develops a much larger bush that shades the ground and shows less injury from heat. This method is best suited to the average garden.

(3) *Light pruning.* For the Floribunda (cluster) and Polyantha roses and certain hybrid tea varieties (such as Mme. Edw. Herriott, Condesa de Sastago, Gruss an Teplitz) which produce showy, short-stemmed blossoms profusely and are best used as flowering shrubs, light pruning to 3 or 4 feet is preferable. These large bushes are very vigorous and productive but require wider spacing than smaller bushes.

Climbing roses are of two types; (1) the hybrid teas and certain others which bloom on short lateral branches from old canes, and (2) the rambler type which blossoms on new canes. The hybrid tea climbers, which include almost all varieties grown here, require very little pruning until the growth becomes too dense. A light pruning to remove all small, weak growth, plus cutting back terminal canes to ¼ to ⅜ inch diameter, and removal each year of one (or more in large climbers) of the old canes to the base of the plant to induce vigorous new shoot growth from the soil line is sufficient.

Roses of the rambler type (of which few are grown in southern Arizona), bloom satisfactorily only on year-old canes, so the old canes are removed after they cease flowering in late spring or during the annual pruning in January.

34. ROOT COMPETITION

The growth of roses is often stunted by too much competition with the roots of trees, shrubs, and Bermuda grass. One exception might be noted. Roses, especially the more vigorous varieties of climbers, planted in new gardens *at the same time* as the competing trees, shrubs, and grass, often thrive; but attempts to establish them in older plantings in soil already filled with roots are less successful.

35. EXCESS HEAT

Too high soil and air temperatures retard both bloom and vegetative growth. Climbers will thrive on an east or north wall, but usually show marked effect of direct and reflected heat on a south or west wall unless they are on a trellis a foot or more from the wall, and the heat effect is reduced rather than eliminated by the air space. High soil temperatures may be combated and moisture conserved by a 2-inch mulch of peat moss, manure, or other organic matter around the plants.

One of the principal causes of the poor results with tree roses in southern Arizona is the effect of exposure of the trunk of the tree roses to the sun. The injury varies from a sunburn which checks growth of the stem tissues on the southwest side of the trunk to death of the tissues affected. This type of injury can be avoided by coating the trunk with cold water paint or shading the south and west sides with strips of board.

36. DELAYED FOLIATION

Following unusually warm winters in the warmer parts of Arizona, some varieties show bare tips of the previous year's canes, or parts of canes on which the buds fail to develop (Pl. III *J*). This is due to lack of sufficient chilling to induce normal growth. The affected canes may be pruned out.

37. EFFECT OF 2-4-D SPRAYS

The new hormone weed killers containing 2-4-D are very injurious to roses at concentrations far below that used for killing

weeds (9). Leaves of shoots sprayed with liquids containing trace amounts of 2-4-D cease growing and the tissues become brittle; the buds also cease growing.

It is very difficult to remove all traces of 2-4-D from the inside walls of spray tanks. After a sprayer is used to kill weeds, it should be thoroughly cleaned with lye or kerosene, then flushed three or four times with warm, soapy water. Better still, two separate sprayers should be used—one for spraying with weed killers and the other for spraying fungicides and insecticides.

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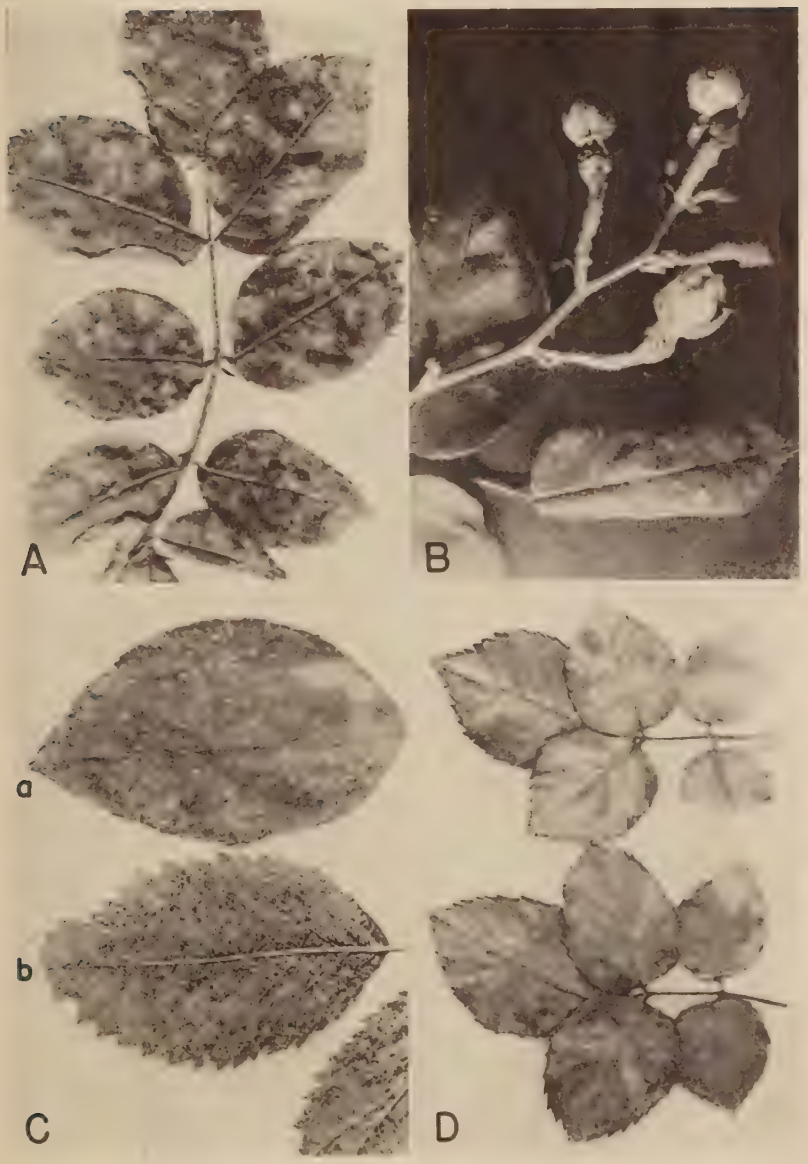

Plate I.—Foliage diseases: *A*, powdery mildew on young rose leaf; *B*, pedicels and rosebuds blighted by powdery mildew; *C*, rose rust on leaflets—(*a*) orange summer spore stage and (*b*) dark brown winter spore stage; *D*, mottled leaves resulting from infection by rose virus 1.

Plate II.—Root and crown diseases: *E*, small spindle-shaped or irregular galls on feeding root of rose. The galls are caused by the root-knot nematode. *F*, incompatability of rootstock and scion showing marked on-growth of scion. Plant was slowly dying without evidence of definite disease. *G*, hairy root, a disease similar to crown gall; *H*, crown of an old climbing rose, showing numerous crown galls. (Shipments represented by specimens *E* and *G* were denied admission to the state by the quarantine inspector.)

Plate III.—Cane diseases: *I*, Dieback of young cane; *J*, delayed defoliation affects certain varieties following abnormally warm winters; *K*, dieback of older cane; *L*, rose canker showing fruiting bodies of the fungus.

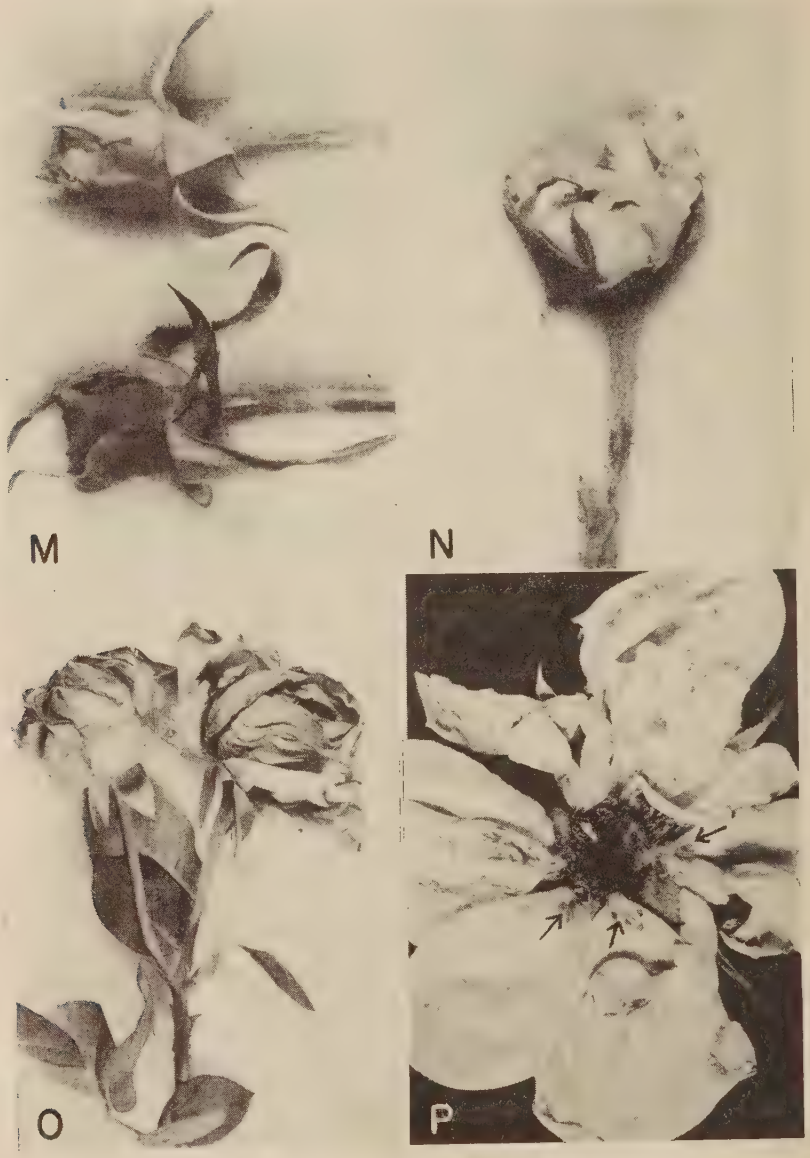

Plate IV.—Flower blemishes; *M*, "bull heads" or stunted abnormal buds resulting from cold injury in early spring or late fall; *N*, margins of petals at first water soaked, then dry and brittle following rain or excess moisture; *O*, drying of petals exposed to hot, dry air in late spring and summer; *P*, thrips damage to rose petals. Note small brown areas near base of petals and shedding of petals.

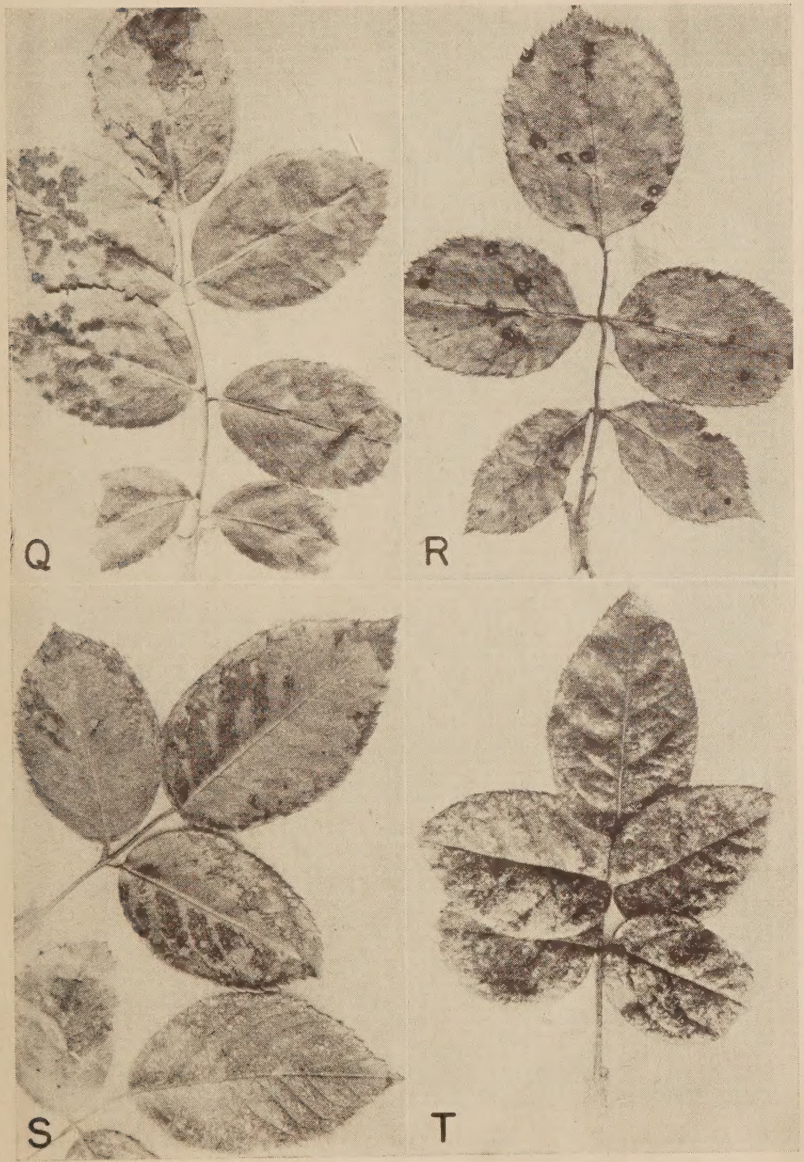

Plate V.—Leaf diseases and blemishes; *Q*, black spot, a fungus disease dependent on moisture, therefore rare in southern Arizona; *R*, anthracnose, another serious disease not yet found in Arizona; *S*, rusty brown or black irregular spots and splotches often found on old leaves as a result of weathering, especially heat and dryness; *T*, white flecking of rose leaves in early spring as result of feeding of grape leafhopper.

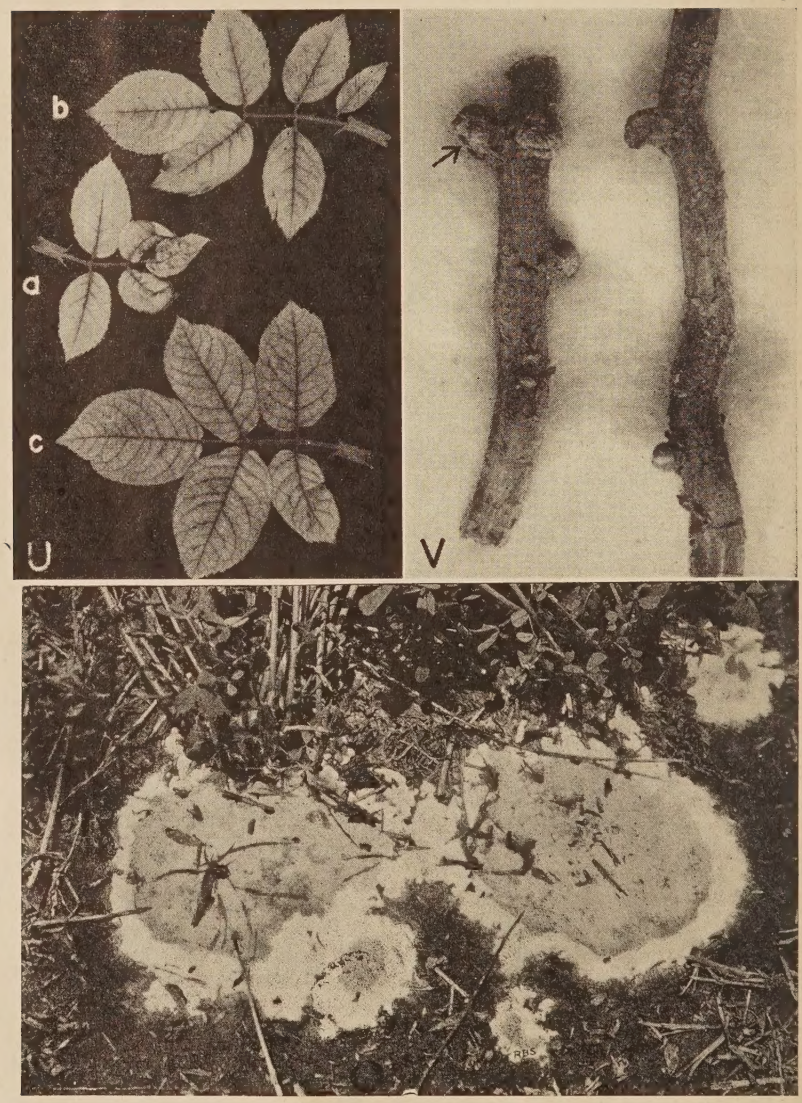

Plate VI.—*U*, lime-induced chlorosis, a very common malady in Arizona: (*a*) severe chlorosis, with stunting and drying of leaflets (*b*) moderate chlorosis, with only main veins retaining green color and (c) mild chlorosis, with green color retained in all veins. *V*, enlarged lenticels on feeding roots of roses budded on Odorata root. Has been confused with root-knot infestation (x3). *Bottom*, spore mats of the root-rot fungus.